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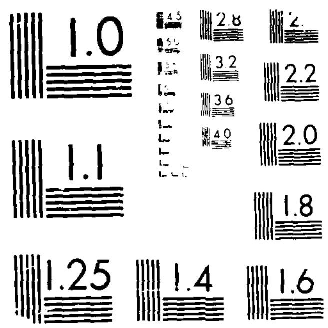

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Equipment has been purchased under this grant to develop and build a research electron beam lithography (EBL) system at Stony Brook for the support of research projects on superconducting electronics. The system is based on an Amray scanning electron microscope (SEM) which has been modified to accept a laser interferometer to monitor stage position. High precision nonmagnetic stages have been added, and interface electronics have been designed and built to permit control of the beam position and beam blanking by an external computer. The completed system is designed to write over a four inch wafer with a resolution of 30nm and a positional accuracy of 100nm.

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Final Report

Equipment for an Advanced Electron Beam Lithography System

Equipment has been purchased under this grant to develop and build a research electron beam lithography (EBL) system at Stony Brook for the support of research projects on superconducting electronics. The system is based on an Amray scanning electron microscope (SEM) which has been modified to accept a laser interferometer to monitor stage position. High precision nonmagnetic stages have been added, and interface electronics have been designed and built to permit control of the beam position and beam blanking by an external computer. The completed system is designed to write over a four inch wafer with a resolution of 30nm and a positional accuracy of 100nm.

The SEM selected for this project was an Amray model 1645. The major features which led to the selection of this machine were: The oversized chamber, which is appproximtely 11 in. × 11 in., is large enough to accommodate stepping motor controlled stages with 4 in. travel. A LaB_6 filament for high beam current was available and was purchased with the instrument. The maximum accelerating voltage is 50KV. This is important when doing ultrahigh resolution (< 100nm) beam writing on standard substrates (e.g., silicon wafers) in order to avoid exposure of the resist by backscattered electrons from the substrate. Finally, an electrostatic beam blanking system with a response time of 0.1μs was provided as part of the instrument.

The major modification made by Amray to this standard SEM was the addition of two ports for a laser interferometer. These ports were positioned so

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that the orthogonal laser beams would intersect the electron beam axis 1 cm below the end cap of the final lens. This 1 cm distance is the planned substrate position during beam writing. A commercial Hewlett Packard laser interferometer system was purchased to monitor the stage position. Differential interferometers were used allowing the interferometer beam splitters and reference mirrors to be placed outside the vacuum system without introducing errors due to the windows and atmosphere. The interferometer has a specified accuracy of 5nm. After allowing for errors due, for example, to the thermal expansion and contraction of the stage, an overall accuracy of better than 100nm in pattern positioning is expected.

The stages purchased for the EBL system were Klinger UT100 stepping motor stages with 4 in. of travel on each axis. These stages were specially modified to remove all magnetic material, since any change in the magnetic field on the electron beam due to stage motion would cause an unknown shift in the beam position and a resulting loss of positional accuracy. The stages are positioned using Aerotech stepping motors and computer interfaceable, programmable controller. The stepping motors are located outside of the vacuum chamber.

Fine positioning of the electron beam in a $100\mu m \times 100\mu m$ field on the substrate is done by computer controlled beam deflection. To stitch these $100\mu m$ fields together in order to write over a larger area, the stage is moved a programmed amount under computer control. The accuracy of the stage itself, about $\pm 1\mu m$, is far less than required, thus an error signal is generated by the laser interferometer to be fed back into the computer beam deflection program in

order to achieve the desired 0.1μm stitching accuracy.

A Hewlett Packard series 300 computer is used to generate the 16–bit addresses for the beam position. An interface between the computer and the SEM has been built; this converts the digital addresses to analog voltages for beam deflection. In addition, the interface controls the system timing: The beam is moved to the programmed position, allowed to settle for a preprogrammed time, unblanked for a second preprogrammed interval, reblanked and then moved to the next position. The interface also can generate separate outputs to the beam scan coils and to the viewing CRT. This permits accurate registration of two sequential layers.

A climate controlled clean room has been built, using University matching funds for this grant, to house this new EBL system.

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